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COMPOSITE OF CLAD FERROUS MEMBER ON CAST ALUMINUM
[Arumikei chuzobozai to tetsukei awasezai tokaranaru fukugozai narabini sono seizohoho]

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/93*

1. Name of this invention

Composite Of Clad Ferrous Member On Cast Aluminum

2. Claims

[1] Composite of clad ferrous member on cast aluminum with the following characteristic:

A clad ferrous member is provided with a concave convex surface, and the tips of convex parts are compressed to form stopper parts vertically extending above concave grooves, wherein a metal layer such as copper, zinc or the like capable of dispersing into both the clad ferrous member and cast aluminum substrate is plated on the concave convex surface to integrate the clad ferrous member and aluminum substrate into one body.

[2] Production method of composite of clad ferrous member on cast aluminum with the following characteristic:

While a ferrous element plate is processed into a concave convex surface by intermittent cold or hot processing or machining, a rolling process is provided to the surface to squash the tips of convex parts to flatten the tips, or in addition to said tip flattening process, the tip areas are bent for a certain angle to form stoppers vertically extending toward the bottoms of concave grooves; then, the concave convex surface is plated with a metal

* Numbers in the margin indicate pagination in the foreign text.

layer such as Cu, Zn or the like capable of dispersing into both the clad ferrous member and a cast aluminum substrate so as to form an integral cast of said aluminum member substrate and ferrous clad plate using the convex concave surface of the ferrous clad as the boundary surface of layers.

[Simple Explanation of Figures] /91

Parts (a) - (d) of Fig. 1 are diagrams showing the production procedures of composite based on this invention. Part (a) of Fig. 2 is a diagram showing the area X in Fig. 1; Part (b) of Fig. 2 is a diagram showing the area Y in Fig. 1; Part (c) of Fig. 2 is an enlarged diagram of the rolling-treated convex concave surface of another operational example. Figure 3 is a scanned EPMA graph of Cu distribution at the boundary surface of composite based on this invention. Figure 4 is a cross-sectional diagram of boundary area of Al substrate and Fe clad of the composite based on this invention.

3. Detailed Explanation of this Invention

[Field of the Invention]

This invention pertains to a composite of clad ferrous member positioned on cast aluminum used as a substrate, being bonded with strong adhesiveness without requiring any adhesive medium between layers, so that the composite can provide excellent abrasion resistance and impact resistance in high temperature corrosive atmosphere. Also, this invention pertains to a mass production method of said composite, which can easily maintain the quality of

products.

[Background of the Current Invention]

The sliding surfaces of an internal-combustion engine or similar device, being placed in high temperature gas atmosphere, receive high thermal load, and there, must provide strong impact/abrasion resistance. However, as engine casings (e.g., rotor housing for high load reciprocal cylinder and rotary engine) are often manufactured using Al alloys, a ferrous element must be adhered to the inside surface in order to manifest the necessary characteristics described above.

Conventionally used techniques for bonding an Al element and Fe element are a simple casting method using machinery bonding and Al-Fin method forming a chemical bonding layer between the Fe and Al. However, the casting method cannot provide adequate layer bonding or manifest chemical bonding to the surface, heat conductivity is too low for practical applications receiving heat and mechanical stress such as internal-combustion engine. On the other hand, although the Al-Fin method being able to manifest chemical bonding is used in applications, such as cylinder and brake drum of reciprocal engine, the problem with this method is that the procedure is complex and requires many steps, as not only does it require preprocessing of ferrous element, but also ferrous element must be soaked in an Al bath and molded while Al is melted or has plasticity, thus making it difficult to insert a thin Fe element into the inside wall of

cylinder or like area. In addition, when a device prepared in this manner is actually used, a thick Fe-Al alloy created at the Fe-Al boundary results in fragility, often worsening the adhesive strength at the area. Therefore, this method cannot be used for mass-producing complicated internal-combustion engines.

In a case of transplant method, which is applied to various engines to a certain degree of success, since, in essence, it uses a thermally sprayed layer, this method accompanies various difficulties. That is, processing the thermally sprayed layer containing Fe oxides is not easy, as the layer is fragile and hard to cut. Also, the layer containing oxides having low heat conductivity functions against the intended heat conductivity improvement by bonding to an Al alloy. Therefore, unless the layer is made thin, problems, such as worsening the cooling effect, occur in mass production. Furthermore, the thermally sprayed layer does not provide sufficient strength, as the shearing strength of the layer is only 6 - 8 Kg/mm^2.

[Disclosure of the Invention] /92

In the prior invention developed by the inventers of the present invention, associated with a method of integrally casting an Al substrate and Fe element, after a rolling-processed metallic net body is placed between layers, the net body is adhered to the Fe element using Cu wax beforehand so as to simultaneously manifest improved mechanical strength and chemical bonding effect of Al-Fe compound for

eliminating aforementioned problems. The present invention provides the same mechanical and chemical layer bonding effectiveness without utilizing a middle net layer. To produce the anchoring effect as a replacement of the middle net layer, concave grooves and sharp convexes are provided with the surface of the iron layer, where the tips of convex parts are compressed to form flattened tips, or such tips are arranged into stopper parts vertically extending toward the bottom of concave grooves in order to thoroughly eliminate the upward movement of Al substrate layer molded in each concave groove, thus preventing the layer from coming out. In addition, to provide the chemical bond, this concave convex surface is plated with a metal layer such as copper, zinc or the like capable of dispersing into both the clad ferrous member and cast aluminum substrate, while the Al-Fe compound can be effectively formed by retaining the heat of melted Al type substrate by utilizing the relatively wide flat-tip heat reception areas.

[Operation of Present Invention]

The following explains the operation of current invention while referring to Fig. 1. In this explanation, an engine casing is used as an example of said internal-combustion engine described above. As shown in Fig. 1, various pieces of soft steel or special steel plates (from here, the term "ferrous plate 1" is used), respectively containing an appropriate amount of C depending on the intended

application, are selected as ferrous member plates. The plate thickness is determined according to the application.

Then, the plate is processed into a concave convex surface **5** containing pointed convex parts **3** and concave grooves using intermittent hot/cold rolling or machining (see Part a of Fig. 2). Next, by intermittently applying a pressure part **6** providing cold rolling or hot rolling, the tip **3** of each convex **3** on the concave convex surface **5** is compressed to create flat tips $\mathbf{2_1}$… as shown in Part b of Fig. 2, or the tip **3** is bent for a certain angle along the rotational direction (to the left in the figure) while squashing each tip **3** to form flat tips $\mathbf{2_1}$… using a rotational extension roller (not shown in the figure) rotating in one direction, so as to create grooves $\mathbf{4_1}$ having stopper parts vertically extending above concave grooves (squashed top area $\mathbf{2_1}$ and bent convex part $\mathbf{3_1}$). In this case, the smaller the bottom angle θ of each concave groove $\mathbf{4_1}$, the better the anchoring effect. However, this bottom angle θ is preferably 60° or less. Also, the apex θ', pitch, and height of the convex part **3** are determined according to the degree of rolling and initial anchoring strength.

After sufficiently degreasing the surface (if intermittent cooling was selected) or removing the oxidized film on the surface (if intermittent heating was selected), the rolling-processed concave convex surface $\mathbf{5_1}$ is plated with a metal layer such as Cu, Zn or the like capable of dispersing into both the clad ferrous member and cast

aluminum substrate (not shown in Fig. 1; refer to Fig. 4). The thickness of 3 - 20 μ is sufficient for this platelayer.

When producing an engine casing as shown in Part c of Fig. 1, the surface of the plated clad ferrous member **1** is curved to form an inner surface shape of engine casing, and the edge **6** is welded to prepare an inner part **7** of the casing. Then, as shown in Part **d** of the figure, after the inner part **7** is inserted into the cast, the Al element casting substrate **9** is integrated to the outside surface to form an engine casing **9**. Note that the inner surface of the ferrous plate **1** of this casing receives Cr and Ni plating.

The rolling-processed convex concave surface $\mathbf{5_1}$ of the prepared engine casing **9** consists of squashed convexes $\mathbf{3_1}$... and concaves $\mathbf{4_1}$... to which stopper parts vertically extending toward the bottom of the concaves are provided by the tips of convexes. Therefore, the Al element substrate poured in each groove $\mathbf{4_1}$ provides with the full anchoring effect to the convex concave surface $\mathbf{5_1}$, thus producing durable mechanical bonding strength. Furthermore, since the concave convex surface is plated with a metal layer **10** capable of dispersing into both the clad ferrous member and cast aluminum substrate, and the tip of each convex part $\mathbf{3_1}$ is squashed to form a relatively wide flat area $\mathbf{2_1}$... for increased heat-reception, the plated metal of the plate layer **10** can effectively disperse into the both materials **8**, **1** from the boundary area by the heat at the flat tip parts $\mathbf{2_1}$..., thus forming an Al-Cu (or Zn etc.) -Fe compound to the boundary surface

area to provide strong chemical bonding. Therefore, the substrate **8** and clad **1** of the compost based on the present invention can manifest significantly high adhesive strength. Figure 3 is a chart of Cu distribution of the Cu plate scanned by an EPMA (electron prove micro analyzer) as an example of chemical bonding at the boundary area. As shown in this graph, Cu is dispersed in both Al and Fe parts, where the dispersion is particularly deep in the Fe clad.

The following explains an operational example of the current invention.

Operational example: /93

A convex concave surface containing grooves (bottom angle = 30°, pitch = 1mm) was provided by vertically engraving the surface of 2 mm thick SS41 material used as a clad ferrous part by machining process.

Then, intermittent rolling was applied to the tips of convex parts at 50% of rolling ratio to flatten the convex apexes to form the rolling-treated convex concave surface shown Part b of Fig. 2. Next, after Cu was plated for 5 µ thick on the convex concave surface of the ferrous plate and molded into a trocoid shape, the processed body was placed in a cast integrated with an Al alloy to form a rotor housing. The adhesion strength between the ferrous plate and Al substrate of the produced rotor housing was 10 Kg/mm^2 in shearing strength. Next, after hard chrome was plated on the rotor housing ferrous surface, its operational strength was tested. As a result, the device provided excellent test results.

As described above, with the method of present invention, a clad ferrous member and Al substrate are mechanically anchored by the convex concave surface formed on the clad ferrous member by rolling. In addition, since this concave convex surface is plated with a metal layer such as copper, zinc or the like capable of dispersing into both the clad ferrous member and cast aluminum substrate, the plated metal is dispersed in both layers with the heat on the flat tips of convex parts and forms Al-Fe chemical bonding to significantly strengthen the adhesion between the substrate and clad plate. As a result, a device having excellent high temperature abrasion resistance and impact resistance can be produced. The following explains the production method and effectiveness of the produced product of the present invention by comparing with the conventional method:

A) Cumbersome processes such as pre-soaking in melted Al required by the Al-Fin method are not needed. Also, an excessive thickness of Fe-Al alloy layer can be prevented to assure the adhesion strength of the layers. Thus, strong layer adhesion can be easily provided without preprocessing.

B) Unlike the transplant method, the method based on this invention does not form a sprayed fragile layer, thus eliminating the chipping and peeling problems, subsequently being able to provide 10 Kg/mm^2 or higher shearing strength compared with the shearing strength of transplant layer which is 6 - 8 Kg/mm^2.

C) The clad Fe element has a concave convex surface, where the tips of convex parts are squashed to form flat surfaces to provide significantly improved heat conductivity.

D) When Ni or Cr plating is provided to the inner surface of the composite clad surface for improving the abrasion resistance, plating can be much easily performed compared with the case of directly plating on the inside surface of Al substrate. Also, its high packing strength allows thinner film formation. Furthermore, as the inner layer defects are much less compared with the transplant method, the plating thickness can be reduced.

E) Compared with the method that utilizes a metallic net or lath metal as an adhesion medium, the method based on this invention does not require a middle medium layer or waxing. Therefore, the production method can be much simpler.

As explained above, in addition to the internal-combustion engine used in the operational example, the present invention provides a technique of producing industrial composite materials being able to manifest excellent impact resistance and friction resistance in a high temperature corrosive environment.

Figure 1

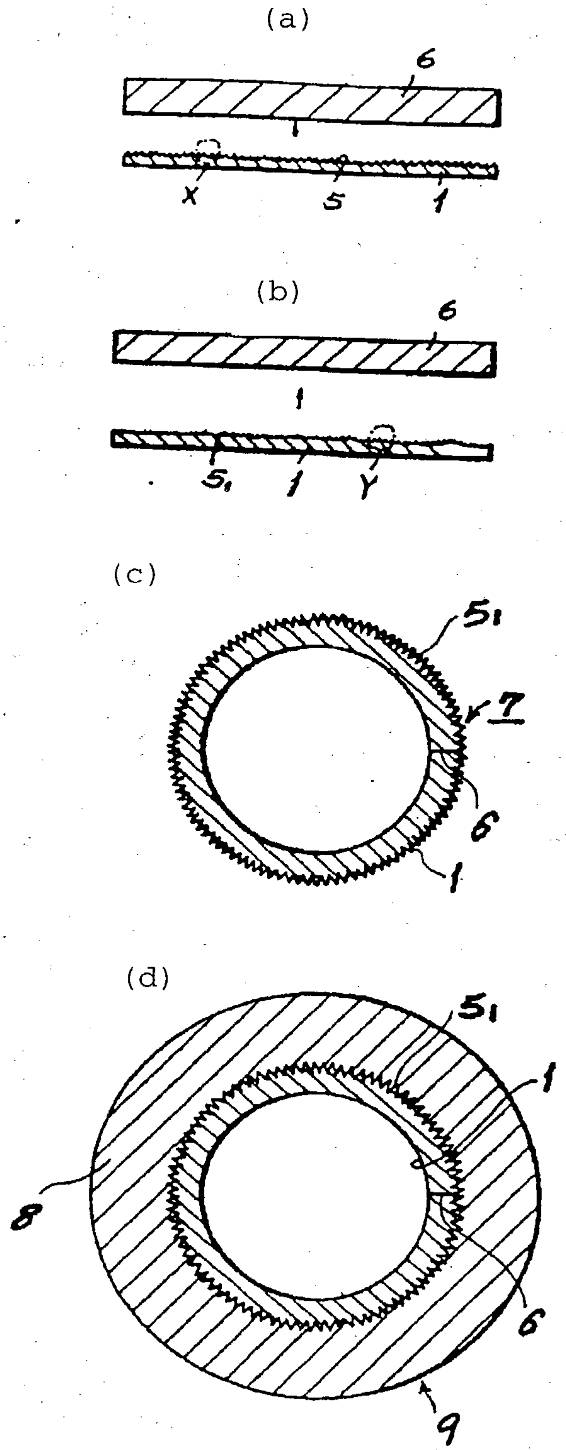


Figure 2 (a)

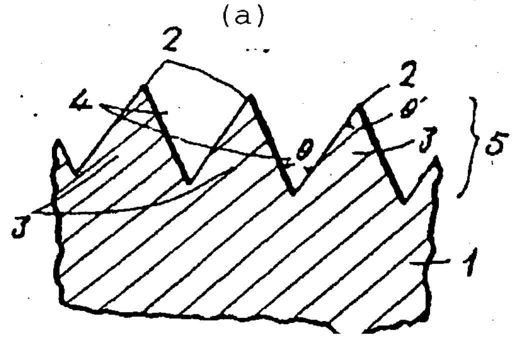


Figure 2 (c)

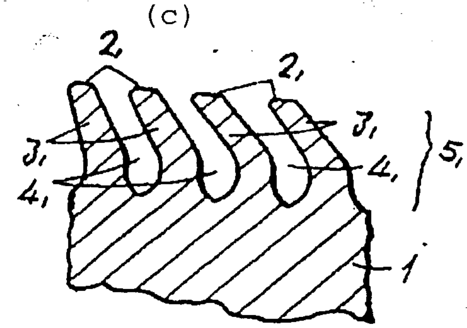


Figure 2 (b)

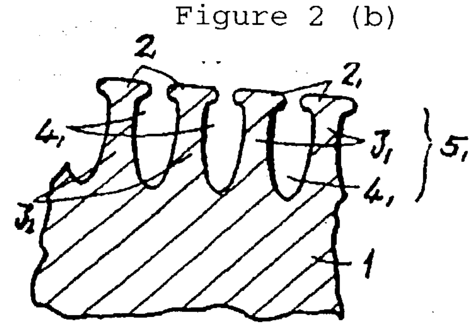


Figure 4

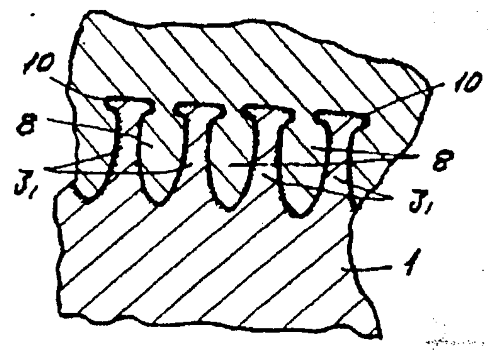
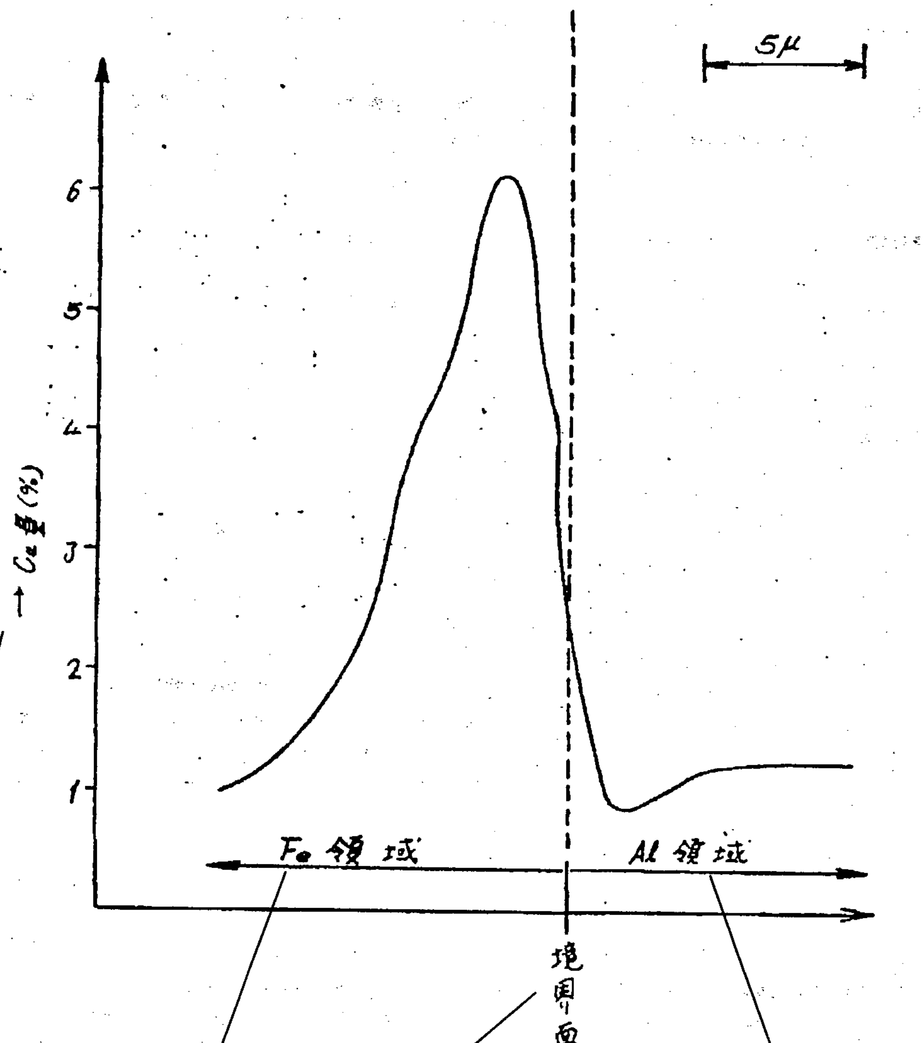


Figure 3



Cu quantity Fe region Boundary surface Al region

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BASIC-ABSTRACT:

A ferrous member to be cald is provided with a concave convex surface. Its convex parts are compressed at their top surfaces to stopper parts vertically extending above concave grooves. This concave convex surface is plated with a metal layer such as Cu, Zn or the like capable of dispersing into both the clad ferrous member and a cast aluminium substrate. The aluminium substrate is cast onto this surface. Thus the ferrous member and the aluminium substrate are assembled as one unit. The concave convex surface is prepd. by cold rolling, hot rolling or machining. the stopper parts are prepd. by squashing the convex parts from above or by bending the convex parts at a certain angle along one direction. The ferrous and aluminium parts are strongly jointed together and the composite has good impact, and friction resistance.

TITLE-TERMS: COMPOSITE CLAD FERROUS MEMBER CAST ALUMINIUM IC ENGINE HEAT TRANSMISSION WEDGE PART

DERWENT-CLASS: M21 M22 P53

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㊹アルミ系鋳造母材と鉄系合せ材とからなる複合材並びにその製造法

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図面の簡単な説明

第1図イ～ニは本発明複合材を得る工程を示したもの、第2図イは第1図イのX部拡大図、ロは第1図ロのY部拡大図、ハは別の実施例による圧延凹凸面の拡大図、第3図は本発明複合材の界面部のCu分布をEPMAによる線走査図として示したグラフであり、第4図は本発明複合材のAℓ系母材とFe系合せ材の界面部の断面拡大図である。

発明の詳細な説明

本発明はアルミ系鋳造体を母材とし鉄系材料を合せ材として両者を途中に別個の接着媒体を介することなく高密着性を保つて複合一体とした高温下の腐食性雰囲気に於ける耐摩耗性、耐衝撃性の優れた複合材と、そのための安定した品質のものが得やすく且つ量産の出来る製造法に関する。

内燃機関等の摺動面は高温のガスふん囲気にふれるため熱的負荷も高く、また高い耐衝撃性と耐摩耗性が要求される。しかしながらエンジンケーシング例えば高負荷のレシプロエンジンのシリンダーやロータリーエンジンのローターハウジングなどはAℓ合金によつて製造される場合が多く、そのためその内面には前述した性質を得るために鉄系材料を接合する必要がある。

従来Aℓ材とFe系材料との結合法としては機械的結合のみを得る鋳ぐるみ法、FeとAℓの間に化学的結合を得る所謂Aℓ-Fin(フイン)法などがあつて使用されている。しかしながら鋳ぐるみ法はその結合力が弱くまた表面に化学的結合を持つていないため熱伝導も悪く内燃機関のように熱応力、機械的応力を受ける場合には使用出来ない。また化学結合を有するAℓ-Fin法はレシプロエンジンのシリンダー、ブレーキドラムなどに用いられているがFe系材料の前処理が複雑でありしかも溶融Aℓ浴に浸しAℓが溶融あるいは塑性を有している間鋳造を行う必要があるなど工程が複雑であり多くの工数を必要とする。そのためシリンダー内壁等に薄いFe系材料をインサートし得るようなことは困難が多い。また実際使用の場合にもFe-Aℓ境界面に厚いFe-Aℓ合金属を生じ、その脆さのために接着強度が低下する場合が多く複雑な形の内燃機械の量産には使用できない。

またトランスプラント法も各種エンジンにおいて実用化され可成りの好果を得ているが溶射層を本質的に内在していることによつて作業上困難が多い。即ち溶射層はFeの酸化物を含有しているため脆く、また切削困難であり加工上問題を生じ易いと共に酸化物を含有するため熱伝導性が低くAℓ合金とその結合による熱伝導性の向上に逆行する。そのため層厚を薄くしないと冷却効果を阻害するなどの問題点を含み量産上の困難が多くなる。さらに溶射層の強度も低くシャー(剪断)強度は6～8kg/mm²に過ぎない。

かかる問題点に鑑み本発明者等はAℓ鋳造母材とFe系合せ材とを鋳ぐるみ一体とする方法に於て、両部材の間に圧延した金属網体を介在させ且

172 < 14,15,17,19

つこの網体をCu系ロウを用いて予かじめFe系合せ材にロウ着させることによつてこの網体による機械的投錨効果とCu系ロウを結合媒体としたAℓ－Fe化合物による化学的結合効果とを同時に期待して上述問題点を一掃した複合材並びにその製造法を開発したが、本発明は更にこれより一歩進んで中間の網体を不要としながら尚先行発明と同じように機械的，化学的な両結合効果を期し得る複合材とその製造法を提供するものである。本発明に於て網体に代る投錨効果は鉄系合せ材の表面に先の尖鋭な山形凸部とV形凹溝とからなる凹凸面を与え其后この凸部の尖端を圧延によつて圧潰して圧扁頭部を形成するかもしくはこれと共に凸部を横方向に倒置させて垂直に対しての抜止部を設けることによつて各凹溝内に鋳造されたAℓ系母材がこの抜止部によつて上方への離脱が完全に阻止されるようにして得られるものであり、又化学的結合はこの凹凸面の全面にCuもしくはZn其他Aℓ，Feに対する拡散性のある金属のメッキを施してこれらのメッキ層が両部材間に拡散すること、並びにこの扁頭部の持つ比較的大きな受熱面積を用いてAℓ系母材溶湯熱を保持させることとによつてAℓ－Fe化合物を有効に形成させることによつて得られるのである。

以下本発明を前述例示の内燃機械部材としてエンジンケーシングを例にとつた実施例図について説明する。先ず第1図の製造工程について云えば使用目的に応じてC含有量を変えた軟鋼より各種炭素鋼、或は特殊鋼の板（以下鉄板1とする）を鉄系合せ板として選ぶ。板厚はその目的に応じて適宜定める。

この鉄板1の表面には熱間もしくは冷間加工或は機械加工によつて第2図イに示したような尖端2を持つた山形の凸部3とV形溝4とからなる凹凸面5を施す。次にこの凹凸面5を表面にした鉄板1に対して第1図イ，ロの如くプレス6を冷間もしくは熱間で圧下することによつて上記凹凸面5を圧形し、例えば第2図ロのように各凸部3の尖端2…を圧潰して圧扁頭部2_1…とするか或は一方向への転動圧延ロール（不図示）によつて第2図ハのように凸部3…の尖端2…を圧扁2_1…とすると共に、凸部3…を転動方向（左方向）に或る傾度をもつて倒置させるかして各凹溝4…の上部に垂直方向の抜止部（圧扁頭部2_1及び倒置

凸部3_1）を有する溝4_1…に変形させる。尚この場合各凹溝4_1の底角θは小さい程後述の投錨効果は良くなるが普通この底角θは60°以下であることが望まれる。又凸部3の頂角θ'やピッチ、高さは爾后の圧延程度、所期の投錨程度等によつて適宜定める。

このようにして圧延凹凸面5_1を表面に形成したら冷間の場合は十分な表面脱脂を行なつた后熱間加工の場合は表面の酸化皮膜の除去を行なつた后にこの凹凸面5_1の部分にCuメッキもしくはZnメッキ其他Fe材、Aℓ材に対して拡散性のある金属のメッキ10を施す（第1図の工程では図示していないが第4図参照）。このメッキ層の厚みは3～20μあれば充分である。

メッキを終えた素材鉄板1は次に第1図ハに示すようにエンジンケーシングを得る場合はエンジンケーシング内面形状に曲成して端部を溶接6してケーシングのインナー部材7とする。その后同図ニの如くこの部材7を鋳型内に装入してその外側にAℓ系鋳造母材8を鋳造一体としてエンジンケーシング9を得る。尚このケーシング9の鉄板1の内面にはCr，Niメッキを行なう。

さて上記工程によつて得られたエンジンケーシング9は鉄板1の表面に形成された圧延凹凸面5_1が前述の如く圧形した凸部3_1…とこれによつて垂直方向に抜止部を有する凹溝4_1…とからなるから各凹溝4_1…内に鋳込まれたAℓ系母材はこの凹凸面5_1によつて完全な投錨効果を発揮し、堅固な機械的結合が得られるのは勿論、この凹凸面5_1にFeとAℓとに対して拡散性のある金属のメッキ10を施してあること並びに凸部3_1の尖端が圧扁されてここに受熱表面積の比較的大きい圧扁頭部2_1…を備えていることによつてAℓ系母材8と鉄板1との境界部は上記圧扁頭部2_1…の受熱によつてメッキ層10のメッキ金属が両部材8、1に対して有効に拡散してゆきこの間にAℓ－Cu（or Zn etc.）－Fe化合物を形成しこれによつて堅固な化学的結合も得られるのである。従つて本発明複合材の母材8と合せ材1との密着性は非常に高いことになる。この境界部の化学的結合を表わす一例として第3図にCuメッキをした場合のCu分布をEPMA（エレクトロンプルーベマイクロアナライダー）による線走査図として現わした。このグラフから

判るように境界部に於てCuはAℓ、Fe両部材に対して夫々拡散をしとりわけFe合せ材には深く拡散していることが明らかとなつている。以下実施例を挙げる。

実施例

Fe系合せ材として厚さ2㎜のSS41材を使用しこれに機械加工により底角30°、ピッチ1㎜の溝を有する凹凸面を該合せ材の垂直方向に削り込む。

この凹凸面の凸部に対し圧延率50％で冷間圧延を行ない凸部の頂部を圧扁して、第2図ロのような圧延凹凸面を形成する。この凹凸面を備えた鉄板に5μのCuメッキを行なつた后所定のトロコイド形状に成型加工し、続いて鋳型内に入れてAℓ合金を鋳造一体としてローターハウジングとした。このようにして製造したローターハウジングの鉄板とAℓ母材との密着力は剪断強度（シヤー強度）10kg／㎟あつた。このローターハウジングの鉄面に硬質クロムメッキを施して実際運転を行なつた結果優れた耐久性を得た。

本発明は以上のように鉄系合せ材とAℓ系鋳造母材とが該合せ材表面に加工した圧延凹凸面によつて機械的投錨結合をすると共にこの凹凸面に形成したCu，Zn其他の金属のメッキ層が受熱表面積の大きな凸部の圧扁頭部の受熱によつてFe系合せ材とAℓ系鋳造母材の夫々に拡散することによつて母材と合せ材との間にこれらメッキ金属を媒体とするAℓ－Feの化学的結合が得られるのでこれら両結合媒体の結果、母材と合せ材との密着性の非常に高い高温耐摩耗性、耐衝撃性部材が得られるのである。本発明の製造法的或は製品的利点を公知のものと比較して述べれば次の如くになる。

A) Aℓ－Fin 法のように溶湯Aℓに浸漬するような面倒な前処理を必要とせず、またFe－Aℓ合金層が厚くなり過ぎないので密着力の低下がなく前処理なしに容易に強固な密着を得る。

B) トランスプラント法に脆い溶射層を有せず欠け、はく離などの問題を起さずトランスプラント層の剪断強度6～8kg／㎟に対し10kg／㎟以上を得ることが出来る。

C) Fe系合せ材の表面に凹凸があり特に凸部の頂部が圧潰されているので表面積が非常に増大されているため熱伝達が大巾に改善される。

D 耐摩耗性改善のため本発明複合材の合せ材内面にNi，Crのメッキを行う場合も直接Aℓ母材内面にメッキする場合に比し容易であり、またバックの強度が大きいため膜厚を薄くすることが可能であり、更にトランスプラント法に較べても層内欠陥が悪いためメッキ厚さを薄くする事も出来る。

E) 金網、ラスメタルなどを媒体として使用する方法に比しても中間媒体の必要のないこと、ロウ付け操作を必要としないことなどの上で工程上大きな利益を得る。

以上によつて本発明は例示の内燃機部材はもとより其他高温腐食性雰囲気下で高い耐衝撃性、耐摩耗性を同時に要求される工業部材用の複合材並びにその製造法として　る有効である。

(57)特許請求の範囲

1 鉄系合せ材の表面には凹凸面が施されてこのうち凸部はその上面を圧扁されて凹溝の上部に垂直方向の抜止部を構成し、かかる凹凸面の凹凸表面には鉄系合せ材とアルミ系鋳造母材の両方に拡散し得る銅、亜鉛其他の金属のメッキが施されて、この凹凸面側にアルミ系鋳造母材が鋳造一体とされて上記鉄系合せ材と界面を構成してなることを特徴とするアルミ系鋳造母材と鉄系合せ材とからなる複合材。

2 鉄系合せ材の表面を冷間加工、熱間加工或は機械加工によつて、凹凸面を形成させると共にこの凹凸面を圧延して凸部の上面を圧扁して、圧扁頭部を形成するか再に左右いずれかに一定傾度を持つて倒置させこれによつて凹溝の上部に垂直方向の抜止部を構成し、かかる圧延凹凸面の表面に銅、亜鉛其他アルミ系鋳造母材と鉄系合せ材の夫夫に対して拡散性のある金属メッキを施し、該鉄系合せ材のこの凹凸面側にアルミ系鋳造母材を鋳造一体とすることを特徴とするアルミ系鋳造母材と鉄系合せ材とからなる複合材の製造法。

(56)引用文献

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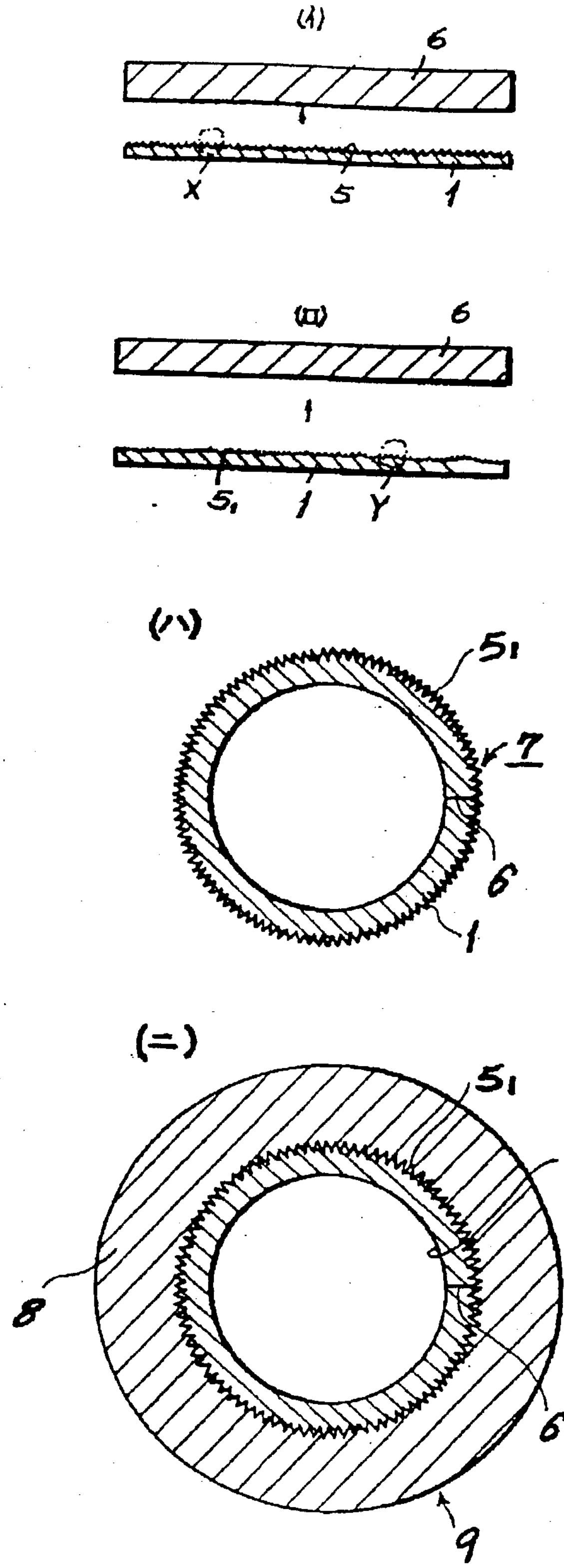
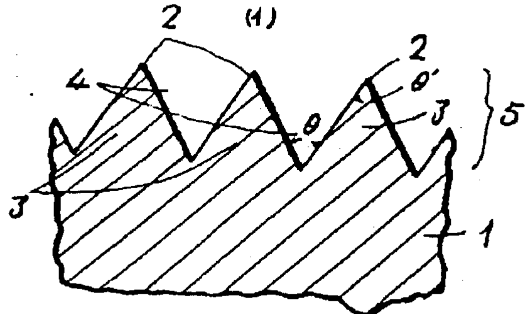
第1図



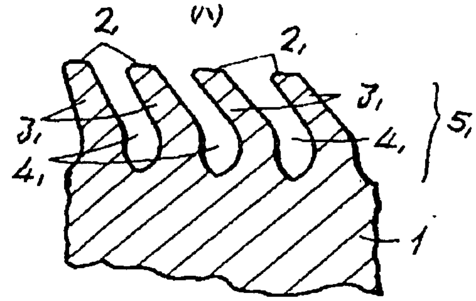
第2図

(イ)



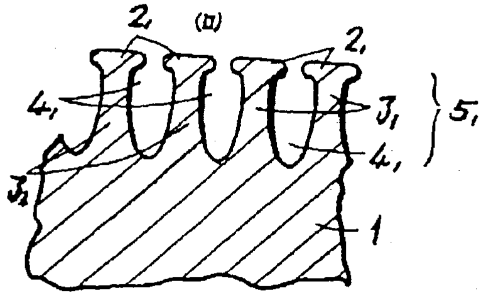
第2図

(ハ)

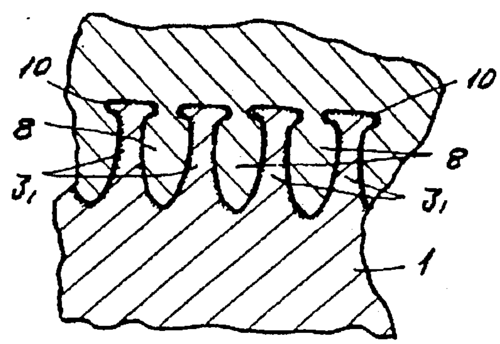


第2図

(ロ)



第4図



第3図